



# MAS BULLETIN

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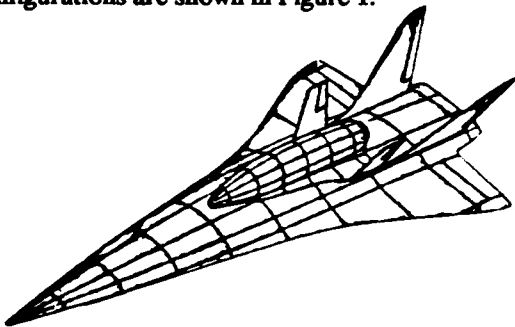
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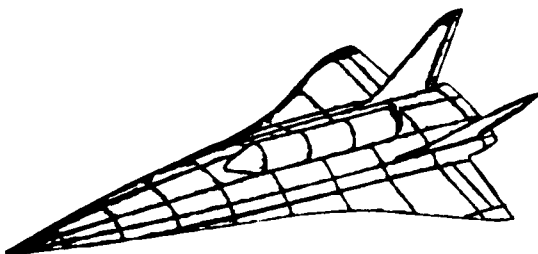
## European Hypersonic Technology Programs Update

**Background.** The following items represent brief descriptions and updates of two European hypersonic technology programs displayed at the Paris Air Show from 9-18 June 1989.

**SÄNGER.** The West German Federal Ministry for Research and Technology (BMFT) is sponsoring the National Hypersonic Technology Program centered on the SÄNGER, a concept for a two-stage, fully reusable space transportation system for crew members and cargo. The first stage would be an air-breathing, turbo-ramjet hypersonic aircraft with cruise capability. The second stage, which would be carried on top of the first stage, would be a reusable rocket-propelled, winged vehicle called the Hypersonic Orbital Reusable Upper Stage (HORUS). The HORUS would be used for manned space missions. A variation of the second stage is an unmanned expendable rocket vehicle used for only transporting cargo called the Cargo Upper Stage (CARGUS). The two configurations are shown in Figure 1.



SÄNGER with HORUS crew transfer, space station supply and servicing



SÄNGER with CARGUS unmanned cargo transport

During the previous year, only slight changes have occurred in the basic design of the SÄNGER program. SÄNGER is currently in Phase I--a detailed systems study aimed at verifying the SÄNGER reference concept--until 1992. During Phase I, the following tasks will have to be completed successfully before proceeding to Phase II:

- Engine component testing including intakes, compressors, combustion chambers, turbines, nozzles, and subsystems
- Engine/airframe integration wind tunnel qualification
- Stage separation at (Mach 6 to 7) wind tunnel qualification
- Metallic structural elements qualification for the first stage at temperatures up to 700°C.

Upon completing Phase I, the Federal Republic of Germany would decide if the SÄNGER should be proposed as an European Space Agency (ESA) program for Phase II. During Phase II (1993-2000), development is envisioned of a 1/4 scale flight test vehicle based on the first stage of the SÄNGER.

**HOTOL.** Horizontal Takeoff and Landing (HOTOL) is a conceptual unmanned, reusable, single-stage-to-orbit spaceplane being developed jointly by British Aerospace and Rolls Royce. This program has existed for several years, but with very limited support from the U.K. government. There are very few new developments, especially concerning the classified HOTOL engines. The HOTOL engine, now designated as the RB 545, is a hybrid, airbreathing/closed cycle rocket engine that uses atmospheric oxygen to sustain combustion of its liquid hydrogen fuel while climbing through the atmosphere. The RB 545 then switches over to onboard, stored liquid oxygen after climbing past the altitude at which external oxygen becomes too scarce to sustain combustion -- roughly 100,000 ft.

HOTOL's aerodynamic design has changed since 1988. Some of the changes from the earlier HOTOL design are:

- Wing sweep increased to 54° for improved transonic penetration
- Wing set further aft and having increased camber
- Forward-fuselage droop of 5°
- Foreplanes made jettisonable during ascent at a speed of about Mach 2.

Figure 1. The SÄNGER

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The only interesting new area of study relating to HOTOL is British Aerospace's effort to develop high temperature materials to use for it or, if the HOTOL project does not proceed, to be used for any other transatmospheric vehicle (TAV) projects, such as the SANGER and the National Aerospace Plane (NASP). Because the huge oxygen tanks (35m long and 6m around) account for half of HOTOL's takeoff weight, research is being done in their design and insulation. The tanks are projected to be made of carbon reinforced with carbon polyethyl-ketone (PEEK) composite. Extensive testing has just begun in this area.

**Conclusion.** Both of these hypersonic technology programs are very preliminary, but the infrastructure for the research and development is being developed. Any technological advances in en-

gine design or materials would have major application to the US NASP or to any other TAV.

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